Alcohol added to the serum causes a movement of exosmose from the interior of the globules to the serum. The globules lose a part of their constituent liquids; and this alteration, which brings on others, is no doubt reproduced in the cells of the various tissues which are bathed by alcoholized liquids.

What it is now my intention to prove is, that in the blood in particular, and in every living organism of analogous constitution (that is to say, formed by cells or utricles filled with a liquid and floating in or bathed by a liquid), it is sufficient to alter, even slightly, the chemical composition of the exterior liquid to cause that of the interior liquid to become modified by endosmose or exosmose.

As soon as I am enabled to resume possession of my laboratory, if I should ever see it again, I propose to follow out the development and application of this principle, either to demonstrate the effects produced by the action of common salt, alcohol, &c. upon the blood, or to show how rapid is that of some agents, of which I have already examined the action, upon the constitution of the globules.

In the mean time I have yielded to the wishes of your eminent President, and I lay upon the table the exposition of those investigations which time may cause to fructify either in my own or more worthy hands. It is a homage that it is a pleasure to my old age to offer to that kind Society which, having, in 1816, guided my youth and the first steps of my career, offers me for the second time, in 1871, after an interval of half a century, the asylum of its friendly hospitality under grievous circumstances to my country.

PROCEEDINGS OF LEARNED SOCIETIES.

ROYAL SOCIETY.

May 11, 1871.—General Sir Edward Sabine, K.C.B., President, in the Chair.

"Action of Heat on Protoplasmic Life." By F. Crace-Calvert, F.R.S.

Those investigators of germ-life who favour the theory of spontaneous generation have assumed that a temperature of 212° Fahr., or the boiling-point of the fluid which they experimented upon, was sufficient to destroy all protoplasmic life, and that the life they subsequently observed in these fluids was developed from non-living matter.

I therefore made several series of experiments, in the hope that they might throw some light on the subject.

The first series was made with a sugar solution, the second with

an infusion of hay, the third with solution of gelatine, and the fourth with water that had been in contact with putrid meat. The hay and putrid-meat solutions were taken because they had often been used by other investigators; sugar was employed, being a well-defined organic compound free from nitrogen which can easily be obtained in a state of purity; and gelatine was used as a nitrogenized body which can be obtained pure and is not coagulated by heat.

To carry out the experiments I prepared a series of small tubes made of very thick and well-annealed glass, each tube about four centimetres in length, and having a bore of five millimetres. The fluid to be operated upon was introduced into them, and left exposed to the atmosphere for sufficient length of time for germ-life to be largely developed. Each tube was then hermetically sealed and wrapped in wire gauze, to prevent any accident to the operator in case of the bursting of any of the tubes. They were then placed in an oil-bath, and gradually heated to the required temperature, at which they were maintained for half an hour.

Sugar Solution.—A solution of sugar was prepared by dissolving 1 part of sugar in 10 parts of water. This solution was made with common water, and exposed all night to the atmosphere, so that life might impregnate it. The fluid was prepared on the 1st of November, 1870, introduced into tubes on the 2nd, and allowed to remain five days. On the 7th of November twelve tubes were kept without being heated, twelve were heated to 212° Fahr., twelve to 300°, and twelve to 400° Fahr.

The contents of the tubes were microscopically examined on the 1st of December, twenty-four days after heating.

Sugar solution not heated.	Heated for half an hour at 212° Fahr.	Heated for half an hour at 300° Fahr.	Heated for half an hour at 400° Fahr.	Heated for half an hour at 500° Fahr.
There were about 30 animalcules under each field of the microscope, principally *small black vibrios*, 2 or 3 microzymes swimming slowly about, 3 or 4 *ordinary swimming vibrios*, and a few Bacteria.	A great portion of the life had disappeared, no animalcules were swimming; still this temperature had not completely destroyed life. 4 or 5 *small black vibrios* were observed moving energetically to and fro; 2 or 3 *ordinary vibrios* were also observed moving energetically in the same position of the field; that is, without swimming about.	The sugar was slightly charred, but the life was not entirely destroyed, as 1 or 2 *ordinary vibrios* and 1 or 2 *small black vibrios* were observed in motion under the field of the microscope.	The sugar was almost entirely decomposed; no trace of life was observed.	No life observed.

Remarks.—The black vibrios here referred to are far more opaque than the other varieties of vibrios, and are the most important of all, as I have found them to resist not only very high temperatures, but all chemical solutions. I shall, in my paper on putrefaction and the action of antiseptics, describe the various vibrios and give drawings of them.

Hay Infusion.—An infusion of hay was made by macerating it in common water for one hour, then filtering the liquor, and leaving it exposed to the atmosphere all night, when it was sealed in the small tubes, twelve of which were used for each experiment. The infusion was made on the 4th of November, sealed in tubes on the 5th, and heated on the 7th.

The results were examined on the 1st of December, 1870, twenty-four days after being heated.

Hay infusion not heated.	Heated for half an hour at 212° Fahr.	Heated for half an hour at 300° Fahr.	Heated for half an hour at 400° Fahr.	Heated for half an hour at 500° Fahr.
Fungous matter was observed growing on the surface of the fluids in two of the tubes. On subjecting the contents of some of the tubes to examination, from 20 to 25 animalcules were observed under each field of the microscope. This kind of life resembled small dots moving energetically to and fro; 1 or 2 ordinary vibrios were also present.	No fungous matter was noticed on the surface in any of the tubes. A few small black vibrios present in the original solution were also present in this.	No fungous matter present, but some of the small black vibrios were still present, although in less numbers.	No fungous matter observed. The fluid was filled with irregular masses of coagulated matter, and life had disappeared.	No life present.

Gelatine Solution.—A solution of gelatine, prepared of such strength that it remained liquid on cooling, was exposed for twenty-four hours to the atmosphere. It was then introduced into the small tubes, and the tubes sealed. The solution was made on the 4th of November, the tubes sealed on the 5th, and subjected to the different temperatures on the 7th.

The fluids were examined on the 1st of December, 1870, twenty-four days after being heated.

Gelatine solution not heated.	Gelatine solution heated for half an hour at 100° Fahr.	Heated for half an hour at 212° Fahr.	Heated for half an hour at 300° Fahr.	Heated for half an hour at 400° Fahr.
There were 7 or 8 animalcules under each field, 5 or 6 of which were quite different to any thing observed in the other fluids. They had long thin bodies, swimming with a peristaltic motion. 1 or 2 ordinary swimming vibrios were also present; but the small black vibrios were absent.	Life seemed to have only slightly decreased, and none of the animalcules were swimming. The peculiar animalcule mentioned in the first column appeared to retain still its peristaltic motion, but not sufficient power to move across the field, a few ordinary vibrios being also observed moving to and fro.	A very decided diminution in the quantity of life present was noticeable.	No life present.	No life present.

Putrid-Meat Fluid.—Water was placed in an open vessel, and a piece of meat suspended in it until it became putrid and contaminated with myriads of animalcules. This fluid was placed in the usual tubes, which were sealed on the 7th of November, and heated on the same day.

The contents of the tubes were subjected to examination on the 1st of December, or twenty-four days after having been heated.

Not heated.	Heated for half an hour at 100° F.	Heated for half an hour at 212° F.	Heated for half an hour at 300° F.	Heated for half an hour at 400° F.	Heated for half an hour at 500° F.
A large quantity of life was present, namely, microzyma and several distinct species of vibrios, among which were a number of the small black ones frequently mentioned.	This temperature had but slightly affected the life present, the animalcules being as numerous as in the liquid not heated, and moving as usual. However, one species of very long vibrios appeared to be considerably affected, as they were much more languid in their movements.	This liquor differed from all the others in being turbid and coagulated. Life was still present; and although heat had deprived the animalcules of the power of locomotion, still they retained a sufficient amount of vital force to place it beyond a doubt that life was not destroyed.	The liquid was quite clear, the albumen (which is coagulated at 200°) appearing to be redissolved. A large quantity of the life in the fluid was destroyed, but some vibrios still remained, the small black ones being the most numerous.	All life had disappeared.	All life had disappeared.

The results recorded in the above Tables show that protoplasmic life is but slightly affected by a temperature of 212° F., and that even at a temperature of 300° F. it is not entirely destroyed, excepting in the case of gelatine. In all the other fluids a temperature of 400° F. is necessary to completely destroy the life. These experiments, therefore, clearly show that the life found by previous experimenters in fluids which have been submitted to heat was not due to heterogenesis, but to life which had remained in the fluids, as I have seen no experiment reported where the temperature to which the fluids were exposed exceeded 300° F.*

I am the more justified in making this statement, as I have repeatedly examined the contents of tubes which had been submitted to a temperature of 400° F., both immediately after cooling and at all periods up to thirty days, and was unable in any instance to detect the slightest trace of life.

This important result corroborates those recorded in my previous paper, and proves that the spontaneous-generation theory is not yet by any means established.

It occurred to me that it might be interesting to examine the influence on pure albumen of the putrid-meat fluids that had been heated, and note whether they still possessed the property of propagating life. A solution was prepared by mixing the albumen of a new-laid egg with pure distilled water free from life (prepared as described in my previous paper). Equal volumes of this solution were placed in six small test-tubes, which had been cleansed with hot vitriol and well washed with pure water. To one tube two drops were added of the putrid-meat solution that had been heated to 100° F., to a second two drops of that heated to 212° F., to a third two drops of that heated to 300° F., to a fourth an equal bulk of fluid heated to 400° F., and to a fifth the same quantity heated to 500° F. In the sixth the albuminous solution, without any thing added, was kept for comparison.

The tubes were sealed, and kept from the 1st of February to the 9th.

Results of Examination.

Albumen solution.	Albumen solution, with putrid-meat liquor, heated to 100° F.	Albumen solution, with putrid-meat liquor, heated to 212° F.	Albumen solution, with putrid-meat liquor, heated to 300° F.	Albumen solution, with putrid-meat liquor, heated to 400° F.	Albumen solution, with putrid-meat liquor, heated to 500° F.
In each drop 2 or 3 small black vibrios, moving to and fro.	Abundance of life.	Abundance of life.	Much less life than in the two fluids previously examined.	In each drop 2 or 3 small black vibrios, moving to and fro.	In each drop 2 or 3 small black vibrios, moving to and fro.

* It is with pleasure that I find these experiments to confirm the suggestion of Dr. Beale, in his work entitled "Disease-Germs, their supposed Origin," page 50 (which I read a few weeks ago), that "living forms might live though exposed, under certain conditions, to a temperature of 350° F."

These results clearly show that, at the temperatures of 100°, 212°, and 300° F., life and its germs had not been destroyed, whilst at 400° F. they had; for the results of the examination were in this case exactly identical with those of the albumen solution itself; and the life found was doubtless introduced in the preparation of the solution, and was not due to any life having remained in the fluids that had been heated.

Although perfectly aware of the interesting researches of Professor Melsens, proving that the most intense cold does not destroy the active power of vaccine lymph, still I thought it desirable to ascertain the effect of a temperature of 15° F. on well-developed germ-life, similar to that which had been subjected to the action of heat.

Some putrid-meat liquor, therefore, containing a large quantity of microzyma and vibrios, was subjected for twenty hours to the influence of a temperature ranging between the freezing-point of water and 17° below that point, when the ice was melted and the liquor examined. The animalcules retained their vitality, but appeared very languid, and their power of locomotion was greatly decreased.

Two hours after melting the ice the liquor was again examined, when the animalcules appeared to be as energetic as before.

June 15, 1871.—General Sir Edward Sabine, K.C.B., President, in the Chair.

On the Organization of the Fossil Plants of the Coal-measures.—Part II. *Lepidodendra* and *Sigillariæ*. By W. C. Williamson, F.R.S., Professor of Natural History in Owens College, Manchester.

The *Lepidodendron selaginoides* described by Mr. Binney, and still more recently by Mr. Carruthers, is taken as the standard of comparison for numerous other forms. It consists of a central medullary axis composed of a combination of transversely barred vessels with similarly barred cells; the vessels are arranged without any special linear order. This tissue is closely surrounded by a second and narrower ring, also of barred vessels, but of smaller size, and arranged in vertical laminæ which radiate from within outwards. These laminæ are separated by short vertical piles of cells, believed to be medullary rays. In the transverse section the intersected mouths of the vessels form radiating lines; and the whole structure is regarded as an early type of an exogenous cylinder; it is from this cylinder alone that the vascular bundles going to the leaves are given off. This woody zone is surrounded by a very thick cortical layer, which is parenchymatous at its inner part, the cells being without definite order; but externally they become prosenchymatous, and are arranged in radiating lines, which latter tendency is observed to manifest itself whenever the bark-cells assume the prosenchymatous type. Outside the bark is an epidermal layer, separated from the rest of the bark by a thin bast-layer of prosenchyma, the cells of which are developed into a tubular and almost vascular form; but the vessels are never barred, being essentially of the fibrous type.

Externally to this bast-layer is a more superficial epiderm of parenchyma, supporting the bases of leaves, which consist of similar parenchymatous tissue. Tangential sections of these outer cortical tissues show that the so-called "decorticated" specimens of *Lepidodendra* and of other allied plants are merely examples that have lost their epidermal layer or had it converted into coal, this layer, strengthened by the bast-tissue of its inner surface, having remained as a hollow cylinder when all the more internal structures had been destroyed or removed.

From this type the author proceeds upwards through a series of examples in which the *vessels* of the medulla become separated from its central *cellular* portions and retreat towards its periphery, forming an outer cylinder of medullary vessels, which are arranged without order and enclose a defined cellular axis; at the same time the encircling ligneous zone of radiating vessels becomes yet more developed, both in the number of its vessels and in the diameter of the cylinder relatively to that of the entire stem. As these changes are produced, the medullary rays separating the laminæ of the woody wedges become more definite, some of them assuming a more composite structure, and the entire organization gradually assuming a more exogenous type; at the same time the cortical portions retain all the essential features of the Lepidodendroid plants. Commencing with the *Lepidodendron selaginoides* just described, we pass on to *L. Harcourtii*, in which there is a distinct cellular axis to the medulla, surrounded by a ring of medullary vessels, external to which is the second or radiating cylinder of vessels, from which alone, as M. Brongniart has very correctly shown, the bundles of vessels supplying the leaves are derived. Then we reach the more highly organized of the forms which Mr. Binney has described under the common name of *Sigillaria vascularis*, in which the woody cylinder is more extensively developed. This conducts us to a series of varieties from which the cells of the medulla have disappeared, but in which there is a very distinct inner cylinder of large barred vessels not arranged in radiating order, and an outer and much more ample cylinder of smaller ones arranged on the exogenous type. In these examples the line of demarcation between the vessels of the medulla and those of the ligneous zone is sometimes straight, and at others boldly crenulated. In the latter examples the outside of the vascular medullary cylinder, detached from its surroundings, exhibits the fluted appearance of a Calamite, for which it might be mistaken, but it lacks the transverse nodal constrictions of that genus. It is to some of these more highly organized *Lepidodendra* just referred to that Corda has applied the name of *Diploxylon*, and Witham that of *Anabathra*, both of which correspond in the closest manner with the *Sigillaria elegans* of M. Brongniart. We are thus brought, by the evidence of internal organization, to the conclusion that the plants which Brongniart has divided into two distinct groups, the one of which he has placed amongst the vascular Cryptogams, and the other amongst the Gymnospermous Exogens, constitute one great natural family.

Of this family numerous other modifications are described. Thus *Ulodendron* and *Halonia*, very closely allied, if not identical genera, have a structure closely corresponding with that of *Lepidodendron Harcourtii*, since they possess a very distinct cellular medullary axis enclosed within the ring of medullary vessels, and, besides, exhibit the enclosing ligneous zone at its minimum stage of development. The remarkable scars of *Ulodendron* and the tubercles of *Halonia* appear to have had their most prominent surfaces composed of the true bark-layer deprived of its epidermal bast and parenchymatous layers, which surround these structures but do not wholly enclose them. These characteristic structures are believed to have supported special organs, into which the epidermal layer of the stem has been prolonged, and which the author believes to have been reproductive cones. *Favularia* corresponds very closely, so far as its cortical layer is concerned, with those already described; and as Brongniart's *Sigillaria elegans* is an unquestionable *Favularia*, the entire series of this subgenus is brought into the closest relationship with the plants described. But the author has further met with some important examples, showing that the stem supported verticils of organs that were neither leaves nor branches, but which are believed to have been cones, thus bringing to light an additional indication of affinity between *Favularia*, *Halonia*, and *Ulodendron*.

Well-marked examples have also been obtained from the Lancashire Lower Coal-measures, the source whence all the specimens described have been obtained, of the outer cortical layers of true *Sigillariæ*. These specimens demonstrate that the bark of these plants is of the true *Lepidodendron* type. No example of an unquestionable *Sigillaria* in which the central woody axis is preserved has yet been seen by the author.

Stigmaria is shown to have been much misunderstood, so far as the details of its structure are concerned, especially of late years. In his memoir on *Sigillaria elegans*, published in 1839, M. Brongniart gave a description of it, which, though limited to a small portion of its structure, was, as far as it went, a remarkably correct one. The plant now well known to be a root of *Sigillaria*, possessed a cellular pith without any trace of a distinct outer zone of medullary vessels, such as is universal amongst the *Lepidodendra*. The pith is immediately surrounded by a thick and well-developed ligneous cylinder, which contains two distinct sets of primary and secondary medullary rays. The primary ones are of large size, and are arranged in regular quincuncial order; they are composed of thick masses of mural cellular tissue. A tangential section of each ray exhibits a lenticular outline, the long axis of which corresponds with that of the stem. These rays pass directly outwards from pith to bark, and separate the larger woody wedges which constitute so distinct a feature in all transverse sections of this zone, and each of which consists of aggregated laminæ of barred vessels disposed in very regular radiating series. The smaller rays consist of vertical piles of cells, arranged in single rows, and often consisting of but one, two, or three cells in each vertical series; these latter are very

numerous and intervene between all the numerous radiating laminæ of vessels that constitute the larger wedges of woody tissue. The vessels going to the rootlets are not given off from the pith, as Goeppert supposed, but from the sides of the woody wedges bounding the *upper* part of the several large lenticular medullary rays, those of the *lower* portion of the ray taking no part in the constitution of the vascular bundles. The vessels of the region in question descend vertically and parallel to each other until they come into contact with the medullary ray, when they are suddenly deflected, in large numbers, in an outward direction, and nearly at right angles to their previous course, to reach the rootlets. But only a small number reach their destination, the great majority of the deflected vessels terminating in the woody zone. A very thick bark surrounds the woody zone. Immediately in contact with the latter it consists of a thin layer of delicate vertically elongated cellular tissue, in which the mural tissues of the outer extremities of the medullary rays become merged. Externally to this structure is a thick parenchyma, which quickly assumes a more or less prosenchymatous form and becomes arranged in thin radiating laminæ as it extends outwards. The epidermal layer consists of cellular parenchyma with vertically elongated cells at its inner surface, which feebly represents the bast-layer of the other forms of Lepidodendroid plants. The rootlets consist of an outer layer of parenchyma, derived from the epidermal parenchyma. Within this is a cylindrical space, the tissue of which has always disappeared. In the centre is a bundle of vessels surrounded by a cylinder of very delicate cellular tissue, prolonged either from one of the medullary rays or from the delicate innermost layer of the bark, because it always accompanies the vessels in their progress outwards through the middle and outer barks.

The facts of which the preceding is a summary lead to the conclusion that all the forms of plants described are but modifications of the Lepidodendroid type. The leaf-scars of the specimens so common in the coal-shales represent tangential sections of the petioles of leaves when such sections are made close to the epidermal layer. The thin film of coal of which these leaf-scars consist, in specimens found both in sandstone and in shale, does not represent the entire bark, as generally thought, and as is implied in the term "decorticated" usually applied to them, but is derived from the epidermal layer. In such specimens all the more central axial structures (viz. the medulla, the wood, and the thick layer of true bark) have disappeared through decay, having been either destroyed or in some instances detached and floated out; the bast-layer of the epiderm has arrested the destruction of the entire cylinder, and formed the mould into which inorganic materials have been introduced. On the other hand, the woody cylinder is the part most frequently preserved in *Stigmaria*, doubtless because, being subterranean, it was protected against the atmospheric action which destroyed so much of the stem.

It is evident that all these Lepidodendroid and Sigillarian plants must be included in one common family, and that the separation

of the latter from the former as a group of Gymnosperms, as suggested by M. Brongniart, must be abandoned. The remarkable development of exogenous woody structures in most members of the entire family indicates the necessity of ceasing to apply either to them or to their living representatives the term Acrogenous. Hence the author proposes a division of the vascular Cryptogams into an exogenous group, containing *Lycopodiaceæ*, *Equisetaceæ*, and the fossil *Calamitaceæ*, and an endogenous group, containing the ferns,—the former uniting the Cryptogams with the Exogens through the *Cycadeæ* and other Gymnosperms, and the latter linking them with the Endogens through the *Palmaceæ*.

MISCELLANEOUS.

On the Skulls of Manidæ.

(In a letter to Dr. J. E. Gray.)

Dear Sir,—In the 'Annals and Magazine of Natural History' for last month I observe a note of yours "On the Malar Bone in the Skulls of Manidæ;" and, as bearing on the explanation you offer regarding the absence of a zygomatic arch in most of the skulls you have seen, I beg to say that in the skeleton of a very young *Manis*, from Western Africa, contained in the Haslar Museum, the arch is formed by a thin band of cartilage connecting the zygomatic processes on the maxilla and squamosal.

I am, dear Sir,

R. N. Hospital, Haslar.
July 3, 1871.

Yours truly,
Charles Barron.

On the Development of the Teeth in Phacochœrus æthiopicus.

By Dr. J. E. Gray, F.R.S. &c.

The British Museum has lately received the skulls of two young *Phacochœrus æthiopicus* from Abyssinia. These skulls can scarcely be distinguished from those of the genus *Sus* by their dentition, as the grinders are not worn, and the large permanent grinder is not developed, but are known by the dilatation and the spreading out of the hinder part of the base of the lower jaw. The younger, which is $4\frac{1}{4}$ inches long, has only the second deciduous grinder developed in the upper jaw and the first and second in the lower jaw. The canines are slender and conical, curved downwards and outwards. The pulp of the two upper cutting-teeth is visible; but they are not cut. The canines of the lower jaw are slender; and the outer cutting-teeth are alone visible.

The larger skull, which is $6\frac{1}{4}$ inches long, has the small conical first and the second and third larger deciduous molars well developed, as are also the two upper cutting-teeth; and the canines are, like those of the smaller skull, bent down, but the alveolar part of the